Circuit breaker

by John Easton

The cardiologists were coming to McCormick Place and they needed electricity and phones. But first, William Mitchell, an electrician and telephone foreman at McCormick Place, needed a cardiologist.

Mitchell, 38, was a key player in preparing the vast convention center for the April 2008 meeting of the American College of Cardiology in Chicago. But his heart was all aflutter—and not because he was nervous about the phone lines. It was simply beating too fast. Mitchell’s resting heart rate doubled the average person’s heart rate, reaching 135 beats per minute even as he slept. “It felt like it would just bounce out of my chest,” he said. When he walked, his heart rate leapt up to 170. At work, he sometimes felt lightheaded and short of breath. He had to take frequent breaks.

*From left:* Bradley Knight, MD; Martin Burlo, DO; John Boshai, MD; and Albert Lin, MD, are part of the cardiac electrophysiology team that treats patients at the Medical Center.

Photo by Dan Dry
If the condition weren’t so familiar to him, Mitchell would have worried more. His father had a rapid heart beat, and his grandfather before that. Beth went untreated. A “stubborn Irishman,” Mitchell also resisted seeing a doctor about it for “maybe six months.”

His wife, a nurse, was nervous. She made an appointment and made sure Mitchell kept it. Cardiologists at a south suburban hospital diagnosed him with atrial fibrillation. They tried to shock his heart back into a normal rhythm, to no effect. They gave him drugs to restore a normal rhythm, but no change. “They couldn’t do it,” Mitchell recalled. “So they sent me to Dr. Knight.”

Bradley P. Knight, MD, professor of Medicine and director of Cardiac Electrophysiology at the University of Chicago Medical Center, sees a lot of atrial fibrillation, a common heart-rhythm abnormality. But Mitchell was a tough case. Usually the accelerated heart rate comes and goes, and sometimes it responds to medications. Mitchell’s unrelenting fibrillation had persisted for months, overloaded the defibrillator and raced on through various medications, placing it in the realm of “permanent” atrial fibrillation, which was un treatable in his father’s and grandfather’s generations. The six-month delay in treatment didn’t help.

New technology for an old condition

The current generation of heart-rhythm experts has radically sped up the growth and power of this emerging specialty. A relatively new and technology-driven field, cardiac electrophysiology began in the 1960s with the description of Wolff-Parkinson-White (WPW) syndrome, a racing heart caused by an extra electrical pathway that delivers duplicate signals telling the heart muscle to contract. When the heart rate multiplies, the chambers don’t have time to refill between contractions and the amount of blood pumped to the lungs and through the body decreases, leading to symptoms such as Mitchell’s.

As there were no catheters in those days, heart surgeons pioneered various mechanical repairs for arrhythmias that were resistant to drugs, isolating and shutting down the aberrant pathway in the operating room. Physicians reported the first successful surgical procedure for WPW syndrome in 1968. By 1982, cardiac electrophysiologists had begun to experiment with less invasive approaches, using a catheter inserted through a vein to disrupt the trouble spot. By the late 1980s, ablation with radio-frequency energy administered via a catheter had become the standard way to eradicate an aberrant electrical pathway without surgery.

“When the tip of this catheter is placed against cardiac tissue and radiofrequency current is applied, a 3 to 5 mm circular area of localized cardiac necrosis is created,” one recent review article described. Knight explained the process more succinctly: “We find the source of the problem, and we zap it.”

Finding the source of an arrhythmia is typically the initial challenge. “It can be a painstaking process,” Knight said. In a normal heart, electricity flows in a regular, measured pattern that coordinates heart muscle contractions. This electrical flow begins in the heart’s natural “pacemaker”—the sinoatrial node in the upper right heart chamber, the right atrium. The electricity flows through the upper chambers, crosses the atrioventricular node—a bridge between upper and lower chambers. Then, the electricity courses through the lower chambers—the ventricles—where it culminates in a carefully coordinated contraction of heart muscle that pushes blood out of the heart to the rest of the body.

A detour anywhere along this electrical highway can disrupt the entire system. And a disruption may result in several different types of cardiac arrhythmias, including atrial fibrillation, atrial flutter, atrioventricular nodal reentry, WPW syndrome and atrial tachycardia—all relegated to the upper chambers of the heart, Knight’s specialty.

To find the arrhythmia’s source, electrophysiologists insert the catheter—a narrow, flexible tube with current-monitoring electrodes at the tip—through a small incision in the groin or neck and snake it up a vein and into the right atrium. Once inside, they place the tip against dozens of points on the inner surface of the heart and measure the intensity and timing of the nearby electrical current that precedes each heart beat. With this data, a computer, sometimes pre-loaded with CT images of the patient’s heart, superimposes the electrical activity onto the known geography of the inner cardiac surface.

Once the physicians have a suspect—one trouble-making tissue that serves as the aberrant electrical pathway—they use radio-frequency energy to damage that tissue and thus disconnect the abnormal circuit. After creating a small lesion, they try to stimulate the heart to beat rapidly again, to make certain they have “ablated” the faulty tissue, silencing the arrhythmia at its source. For many arrhythmias, such as WPW, the target is as small as a hair and can be successfully ablated with a single application of energy. For other rhythms such as atrial fibrillation, the arrhythmia that Mitchell suffered from, the target is a large amount of tissue and requires the delivery of multiple small lesions. In Mitchell’s case, it required almost 60 burns before physicians felt they had eliminated the source of the arrhythmia. The entire procedure took five hours. Mitchell has been fine since.

Ever onward

The heartbeats may have slowed but the technology races ahead. “Our tools, the equipment and the software, keep getting more and more sophisticated,” Knight said. Better cardiac imaging and increased computing power brings new precision to the anatomical and electrical maps of the heart, which cuts down on the time required for each case and makes it safer for the patient. And the new tools can extend treatment to patients who may not have had access before. Last summer, Knight was the first physician in the world to use a new device designed to make it safer for cardiologists to burn a small hole through the atrial septum,
"Our tools, the equipment and the software keep getting more and more sophisticated."

Bradley P. Knight, MD

The thin membrane that separates the two upper chambers of the heart, allowing the catheter to pass safely from the right side of the heart to the left. "Having the right tools to control each step," Knight said, "enhances our confidence and extends the number of patients we can help."

Barbara Ganschow, 80, suffered from atrial fibrillation. An avid traveler who was remarkably healthy for the first 75 years of her life, she noticed the irregular heart rhythm during a 23-hour flight back to Chicago from South Africa. "I just felt awful," she recalled. "It was a miserable flight."

Cardiac ablation at another hospital worked for her—but only for three years. Then the abnormal rhythm returned, this time even worse. Because of scar tissue that formed after the first procedure, however, her doctors could not repeat the initial treatment, which required passing the catheter across the atrial septum to the left atrium, where the problem was centered.

So, like Mitchell, Ganschow's doctors referred her to Knight. Using the new device, he burned a small hole in her atrial septum, passed the catheter smoothly from the right to the left atrium and eradicated the problem. Ganschow went home the next day.

"I feel fantastic," she reported one week after treatment. "I have my life back, and I'm so glad."

And sometimes the technology makes life easier for the physicians. Last fall, the University's electrophysiology and interventional labs installed new high-tech catheterization systems that rely on giant computer-controlled magnets to guide the catheter into place. Instead of the doctor manually manipulating the catheter to multiple locations within the heart, a magnetic field gently steers the catheter tip through a predetermined path within the heart. "This system appears to be a very safe, gentle approach," said Knight.

The technology benefits the physicians, too. Instead of wearing 20 pounds of lead to shield themselves from radiation produced by a fluoroscope as they maneuver the catheter, doctors can sit comfortably in the control room watching computer screens while the new system puts the treatment tools in place, like a GPS that can drive itself. Those full metal jackets "took a toll on me, on all of us," said Knight. Now, like the lead shields, his persistent foot pain has gone away.

Martin Burke, DO, analyzes a patient's heart rhythms based on recent test results. Photo by Dan Dry